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FORECAST OF THE 1974 PINK SALMON RUNS, SOUTHEASTERN ALASKA

By:
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1973

ALASKA DEPARTMENT OF FISH AND GAME
Subport Building, Juneau, Alaska 99801

James W. Brooks
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FORECAST OF THE 1974 PINK SALMON RUNS, SOUTHEASTERN ALASKA[1/]

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ABSTRACT

The Southeastern Alaska pink salmon forecast is based on the relationship between pre-emergent fry abundance indices, estuarine water temperatures and subsequent adult returns. In 1974, approximately 9.3 million pink salmon are expected to return to northern Southeastern with a possible range of 7.4 to 11.2 million. A rather weak return of about 6.8 million pinks with a possible range of 4.4 to 9.2 million is expected for southern Southeastern. Forecasts by district and timing segments indicates considerable variation in run strengths. In some areas, runs are expected to be so weak that, even without a harvest, it is unlikely that escapement goals will be achieved. The most probable harvests in northern and southern Southeastern are expected to be approximately 5.7 million and 1.6 million, respectively. However, actual catches in 1974 may vary from 3.8 to 7.6 million fish in the north and from 0.0 to 4.0 million in the south, depending on the magnitude of actual total returns.

INTRODUCTION

The purpose of this report is to present the 1974 pink salmon forecast, analyze the success of the 1973 forecast, and provide a reference of data needed for future forecasts. This report is the ninth in a series concerning forecast studies in Southeastern Alaska (Noerenberg, et al., 1964; Hoffman, 1965, 1966; Smedley and Seibel, 1967; Smedley, 1968; Valentine, et al., 1970; Durley and Seibel, 1972; Durley, 1973).

Annual pink salmon forecasts are of importance to the fishing industry, both fishermen and processors, and to fishery managers for operational planning and regulatory decision-making. To properly manage our fisheries, which means allowing maximum harvest while maintaining desired escapement levels, we must be able to accurately forecast the magnitude of each segment of the runs which pass through the fisheries from early to late season, and then proportionately harvest those run segments.

The primary objectives of the Southeastern Alaska pink salmon forecast program are: (1) to accurately predict the strength of the total return by timing segment and by management area or district, and (2) to determine the optimum escapement or carrying capacity of the salmon streams in Southeastern. Expected harvest levels can be estimated by subtracting escapement goals from predicted returns.

Optimum Escapements

Escapements to many sections of Southeastern Alaska continue to be below levels needed to build runs on a continuing basis. New base-levels of escapement were established in 1971 and must be adhered to, especially during expected periods of poor returns, if Southeastern Alaska pink salmon production is to be increased to maximum levels. Increasing escapements alone, however, will not provide the entire answer to the problem. Consideration must be given to the timing pattern of the returning runs to provide good distribution to and within the various spawning streams.

Geographical Areas of Study

Southeastern Alaska, for the purpose of pink salmon forecasting, is divided into northern Southeastern and southern Southeastern (Figure 1).

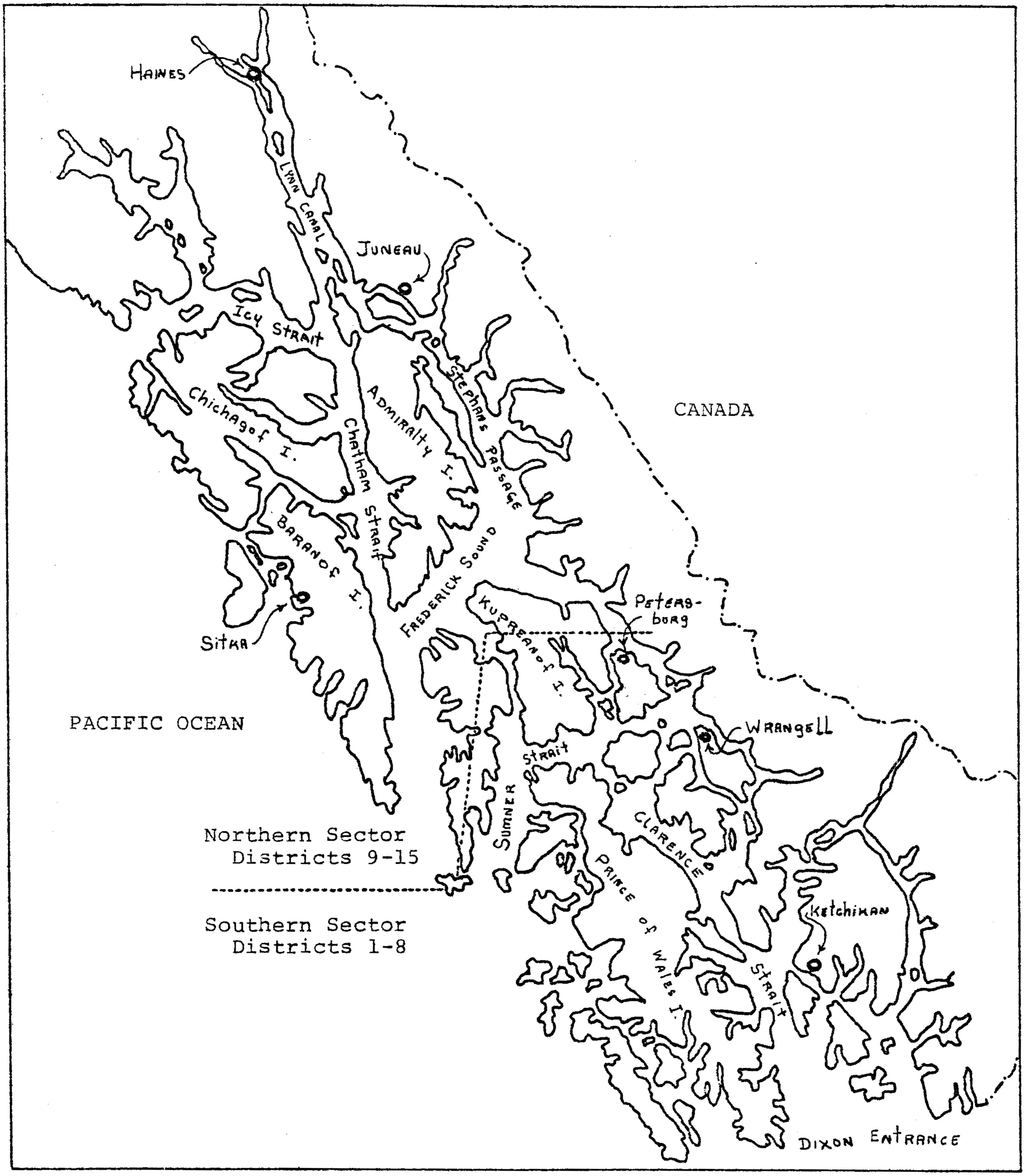


Figure 1. Map of Southeastern Alaska showing division between northern and southern areas.

Tagging studies have indicated that upon approaching the outer coast of Southeastern Alaska, pink salmon separate into two groups, the northern group entering via Icy Straits and lower Chatham Strait and the southern group entering via Sumner Strait and Dixon Entrance.

DEFINITIONS

Because of the terms return and escapement frequently occur throughout this report, it is important to briefly explain the terms as they are used in management of the stocks. Returns are more precisely return indices, for they represent the sum of commercial catches and escapement indices rather than estimates of total escapements. The term escapement is used as an abbreviation for 'escapement index'. Since it is not possible to accurately estimate the total number of pink salmon spawners in Southeastern Alaska, an index or relative measure of escapement is obtained annually. Assuming the relationship between total escapements and escapement indices is constant, the escapement index can be substituted for total escapement for in-season management and for estimating escapement goals.

SUCCESS OF 1973 FORECAST

Success of the 1973 forecast and how it compares to past year's results are summarized in Table 1. In northern Southeastern, the observed return of 4.0 million pink salmon was less than the predicted point estimate of 6.0 million,but fell within the lower end (3.5 - 6.0 million) of the range estimate. In southern Southeastern, the observed return was 7.0 million pinks or 7.1 million less than the predicted point estimate and fell well outside the lower end of the range estimate.

The over-estimates of returns are believed not to indicate a failure of the method used to index pre-emergent fry abundance. Some changes in sampling design were made back in 1971 and these changes may have affected the fry density values obtained in 1971 and 1972 in relation to those of past years. However, it is believed that the sampling changes would not account for such a large error in the forecasts.

Early Marine Mortality of Fry

Existing evidence indicates the unexpected poor return to northern Southeastern in 1972 and 1973 was the result of high early marine mortality

Table 1. Comparison of forecast and actual returns of pink salmon for northern and southern Southeastern Alaska, 1967-1972. (Number of salmon in millions).

Return year	Predicted return	Actual return	Forecast error
		Southern Southeastern	
1967	4.8	2.2	+2.6
1968	21.5	20.6	+0.9
1969	3.2	3.2	+0.0
1970	18.7	9.7	+9.0
1971	4.3	11.0	-6.7
1972	13.7	13.9	-0.2
1973	14.1	7.0 1/	+7.1
		Northern Southeastern	
1967	4.9	4.1	+0.8
1968	6.2	12.6	-6.4
1969	4.0	5.8	-1.8
1970	9.0	7.6	+1.4
1971	8.5	5.5	+3.0
1972	12.9	6.0	+6.9
1973	6.0	4.0 1/	+2.0

1/ Preliminary estimates

of fry. Several reasons indicate this: (1) the 1973 pink salmon predictions based on fry abundance in Southeastern Alaska, Kodiak and the Alaska Peninsula all indicated greater returns than actually occurred, and (2) the spring weather conditions and surface temperatures throughout Alaska during March, April, May and June 1972, when fry entered the estuaries were below average and in Southeastern Alaska they fell several degrees below the average. For instance, the surface seawater temperatures at Juneau during the spring months (March, April, May and June) of 1972 were the third coldest since 1937. Likewise, in Ketchikan, the water temperatures were the second coldest since 1937 (Figure 2). It is known that variations in estuarine and ocean mortality occur, however, it was believed that since forecasts at Prince William Sound had been relatively accurate, the variation in ocean mortality would not decrease the accuracy of the forecasts below acceptable limits. However, in 1972 and 1973, marine mortality appeared to have caused considerable error in most forecasts. Analysis supporting this hypothesis is included in a following section relating temperatures to forecast error.

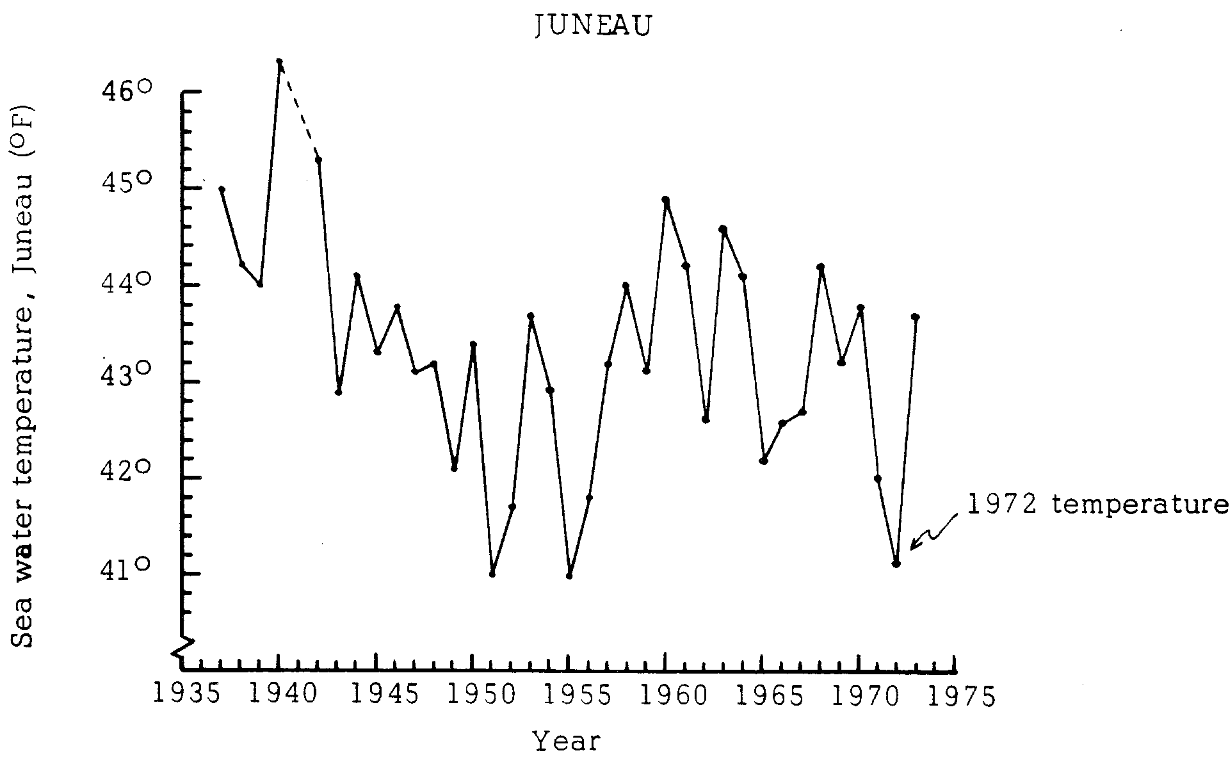
A monitoring study to determine annual changes in temperatures and salinities throughout northern Southeastern was initiated in the spring of 1973. Temperature changes will be used as an indicator of environmental change which may affect salmon fry survival. Data are gathered during March, April, and May when survival in the estuaries is most likely to be affected.

Distribution of the 1973 Return

Northern Southeastern. Although the return was less than predicted, the relative strength of runs by timing segment and management area followed the predicted proportions. The proportion of early run fish was, as predicted, about 45% of the total return. The proportion of middle and late run fish were, also as predicted, about 28% and 32% respectively. The returns to the middle run streams in Gambier-Pybus bays and Peril Straits were very poor as predicted.

Early in the fishery, close monitoring of salmon escapements into the bays and streams, indicated that the early run and likely the later runs would not develop as expected. Fishing time was curtailed and areas closed but still only fair success was made in achieving the escapement index goals. Escapement to the northern Regulatory Districts 9-14 was approximately half of the desired goal (Figure 3).

Southern Southeastern. As in the northern forecast, relative run strengths followed the predicted proportions even though the actual return was half the forecasted return. The early run segment was very weak as



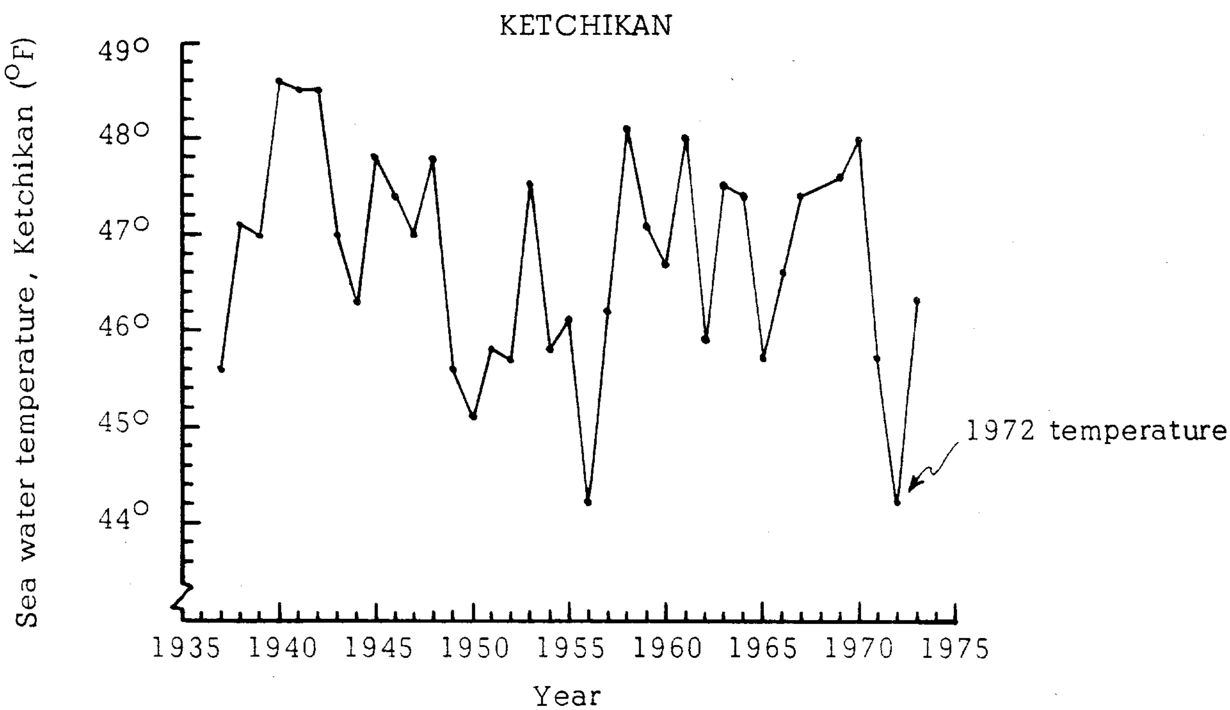


Figure 2. Annual sea water temperatures (°F) for the months March, April, May and June 1937-1973 at Juneau and Ketchikan.
Data source: Monthly publication by National Ocean Survey, NOAA, Rockville, Maryland.

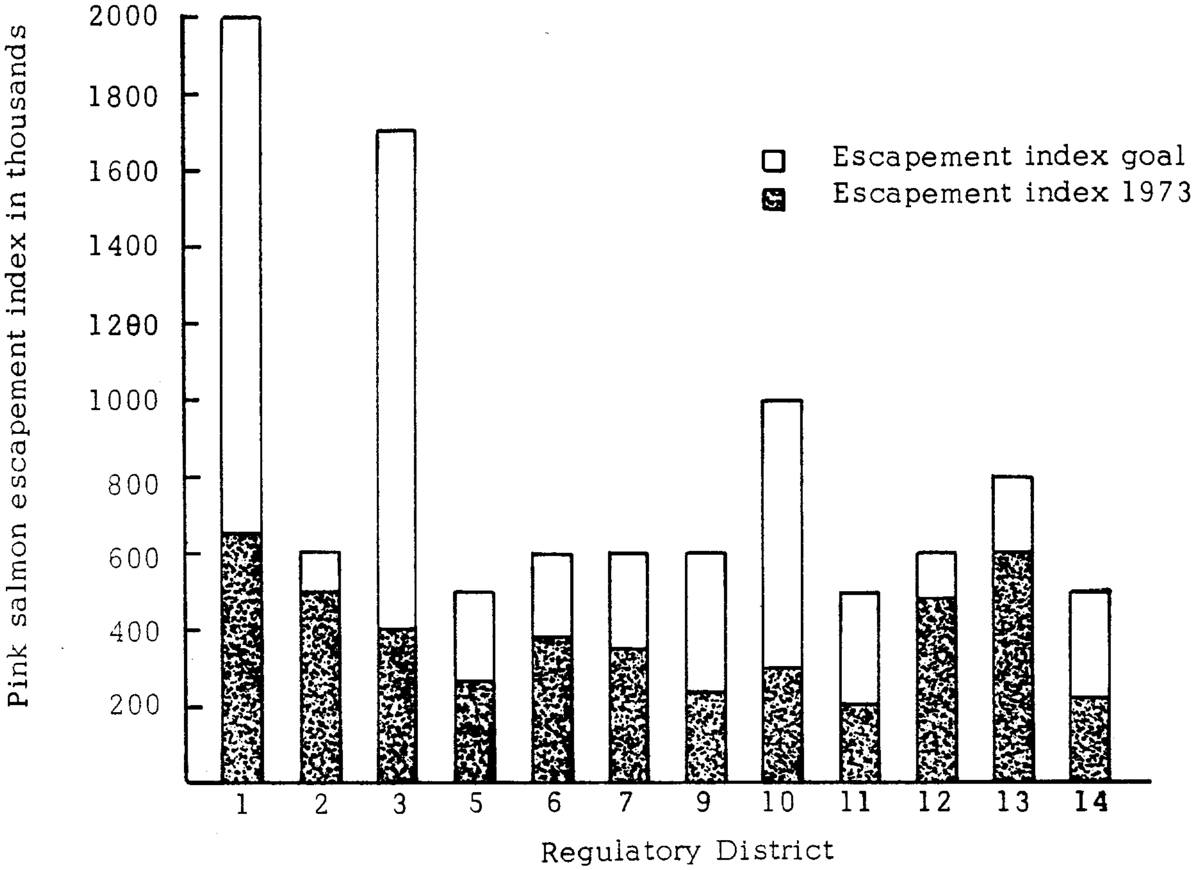


Figure 3. Preliminary 1973 pink salmon escapement indices compared to escapement index goals by major regulatory district, Southeastern Alaska.

predicted, comprising only about 11% of the total return. The middle and late runs expected to be of about average strength were poor because of the overall weak return.

The predicted allowable harvest of 8.1 million pinks for southern Southeastern was about 4.0 million high. The early segment of the return was weak as predicted, and was protected by a late opening and very restrictive fishing time in Regulatory District 1. The middle and late run segments were well below forecasted levels. Little separation in the middle and late segments occurred, as was indicated by the catches. The late runs may have entered the fishery earlier than usual. Good early catches of middle run pinks appeared to support the forecast, but after the first 2 weeks of good fishing, catches fell rapidly.

Escapement goals were not achieved for middle and late run segments. Escapement to the southern Regulatory Districts 1-7 was approximately 45 percent of the desired goal (Figure 3). Only through very restrictive fishing effort, when the catch started to drop unexpectedly, was it possible to achieve the escapement.

1974 PINK SALMON FORECAST

1973 Pre-emergent Fry Sampling Methods

The standard technique employed to enable forecasting has been hydraulic sampling of pre-emergent fry in the spawning riffles during the spring months. Spawning riffles in important and accessible streams are excavated in a manner which should give reliable year-to-year comparisons of relative fry abundance. Sampling is conducted just prior to fry migration to salt water, when early freshwater mortality is no longer a major consideration.

The pre-emergent index streams receive approximately 42% of the escapement to Southeastern Alaska. Therefore, they can be said to produce nearly half of the returning runs. These streams, and the consistent areas within the streams, are sampled annually, thus establishing an index study area. It is assumed that salmon production from the index study streams is indicative of production from all Southeastern Alaska pink salmon streams.

The streams sampled annually comprise an index group which remains constant. Certain weighting factors are employed to adjust for variations in the percentage contribution of the index streams to total pink salmon production.

First, the fry index for a given district is obtained by dividing the total number of fry collected while sampling in the district by the total number of samples taken in the district. This procedure results in weighting stream indices according to apportionment of sampling effort, which approximates stream production potential. The district fry indices are then weighted by the district average escapements for the past 5 years, thus weighting district indices by measures of the relative district production potentials. However, only the fry indices for the northern districts were weighted by the average escapements. Analysis of the fry abundance-return relationship for southern Southeastern indicated that, with the 1972 fry-return data included, weighting by district escapements resulted in an increased variation in the fry-return relationship. It is not apparent why weighting by escapement causes greater variation in the southern data. In both the above weighting procedures, indirect measures of production potential of streams and district were used. However, in conjunction with current optimum escapement studies, attempts are being made to develop direct estimates of production potential for individual streams.

Study streams and areas within study streams have changed somewhat over the past six years. However, the number of index streams has been stabilized at about 100 in recent years. In a continuing effort to upgrade the forecast, better coverage within the large streams is being achieved by sampling select spawning riffles throughout the length of the streams, thereby covering segments of the entire spawning populations. Upstream areas of the larger streams generally provide the greater portion of spawning area and should be sampled along with the lower reaches of the streams to provide a total production index. Until recently, many of the larger index streams had been sampled only in the easily accessible inter-tidal and lower stream areas. More recently, use of lighter, more efficient gear and increased use of helicopters have improved coverage, thus increasing the quality and quantity of sampling.

Fry density information obtained from new upstream areas will not be incorporated into the forecast analysis until it is determined how the data will affect the existing index-return relationship. Several years data from these new areas may be required before a base is established which can be used to provide more accurate forecasts.

In 1973, pre-emergent field work began the first week in March and continued into the second week of April. A total of eight crews worked throughout Southeastern Alaska sampling 95 streams. Of the 95 streams sampled, 45 were located in the southern half and 50 in the northern half. A total of 5,207 samples were collected.

Fry development at the end of March appeared to be normal in comparison with past years and there was no apparent early migration of fry which may have been missed by sampling.

Estuarine Temperatures as a Factor Influencing Forecast Results

Until this year, the pink salmon forecasts have been based wholly on the relationship of pre-emergent fry abundance indices and resultant returns. To use this relationship an assumption was made that fry, after leaving the streams, were subjected to a relatively stable marine environment which would result in little annual variation in mortality and, therefore, would not significantly affect the fry-return relationship. This assumption was primarily based on the fact that the past forecasts of returns to Prince William Sound based on the fry-return relationship had been relatively accurate, indicating little variation in marine mortality.

Marine mortality in Alaska appears to have played a more significant role in determining adult return size in recent years than previously. In 1972 and 1973, most pink salmon forecasts throughout Alaska were in error. In most instances, the returns were considerably less than those predicted, suggesting the occurrence of below average survival after the fry departed the streams.

Studies on the mortality of pink salmon in British Columbia indicate that wide variation in marine survival occurs (Neave, 1953; Hunter, 1959). The studies demonstrated that variations in sea survival are extremely important in determining the size of runs. Parker (1962) and other investigators found that after fry leave the streams estuarial condition is the dominant factor in controlling adult pink salmon survival rates and that mortality is relatively constant beyond estuarial influence. Neave (1953) considers food abundance as probably the one most important factor affecting survival of young.

Since it would be difficult to measure factors that may directly affect young pink salmon such as food availability, many investigators have used seawater temperature as an indicator of the changes in estuarine ecological conditions. Wickett (1958) and Vernon (1958) demonstrated significant correlation between success of brood years, and temperature and salinity of coastal waters (British Columbia) during the summer months following seaward migration.

Continuous sea surface temperature data are available for several locations in Southeastern Alaska, and are usable as an indicator of variations in estuarine conditions. Surface seawater temperature records are available from three locations; Juneau, Sitka and Ketchikan. The temperatures taken in the vicinity of these towns may not be the best indicators of the conditions in the estuaries near the salmon streams, but might provide an indication of gross annual differences in water temperatures in the northern and southern areas. Temperatures during the months of March, April, May and possibly June are assumed to be the most critical, for it is during these months that pink salmon fry migrate downstream to the estuaries and begin feeding.

Following the work by Vernon (1958), combinations of monthly sea surface temperature data were chosen, that when combined with the pre-emergent fry indices provided the closest fit between the actual and the predicted values of run strength. The results obtained indicated that annual variations in estuarine temperatures play a major part in variation of run strength returning to Southeastern Alaska.

Relation of Return Strength to a Combination of Pre-emergent Fry Indices and Estuarine Temperatures

Northern Southeastern. As mentioned earlier, fry indices of individual streams were weighted according to sampling effort to arrive at district indices. District fry values were adjusted to eliminate possible error resulting from annual variation in contributions of the sample streams to the total production. Seibel (1972) found that by such an adjustment of Prince William Sound pre-emergent fry data, the standard error of forecast was significantly reduced. The district fry indices were then weighted by the district 5-year moving average escapement, thus weighting the fry indices by measures of relative stream and district production potential.

Analysis of the pre-emergent fry index and return data for the years 1966-1971 (Table 2) by simple linear regression indicated these two factors were closely correlated ($r = 0.99$, $n = 5$). When the fry-return data for the two most recent years (1971-1973) were added, the correlation was substantially weakened ($r = 0.45$, $n = 7$). From the linear equation ($Y = 2.36 + 0.027X$) relating fry-return data for all years of study, return strengths were estimated for each year and compared with the actual return strengths (Figure 4A). The standard error of estimate is $\pm$ 2.43 million pink salmon.

The pre-emergent fry data for the years 1966-1972, when combined with sea surface temperature data indicated a close total correlation ($R = 0.96$, $n = 7$) with the return strength.

The multiple regression equation for this relationship was calculated as follows:

$$Y = -42.435 + 0.078X_1 + 5.537X_2$$

Where Y = return strength in millions of pinks
X_1 = weighted pre-emergent fry index in year previous to return

Table 2. Comparison of pre-emergent fry indices, surface seawater temperatures (°C) and strength of pink salmon return in millions of fish to Southeastern Alaska, 1966-1973.

Northern Southeastern

Year of return	Pre-emergent 1/ fry index (X_1)	Seawater temperature °C 2/ Juneau and Sitka (X_2)	Return (Y)
1967	99.4	6.8	4.1
1968	210.0	6.9	12.6
1969	106.9	7.4	5.8
1970	149.9	6.8	7.6
1971	110.7	7.2	5.5
1972	196.6	6.0	6.1
1973	206.5	5.6	4.0 (preliminary)
1974	173.9	6.9	9.3 Forecast

Southern Southeastern

Year of return	Pre-emergent 3/ fry index (X_1)	Seawater temperature °C 4/ Ketchikan (X_2)	Return (Y)
1967	72.1	6.7	2.2
1968	180.3	7.1	20.6
1969	83.9	(missing)	3.2
1970	127.3	6.7	9.7
1971	121.3	7.8	11.0
1972	143.6	6.2	14.9
1973	120.7	5.4	7.0 (preliminary)
1974	101.8	7.0	6.8 Forecast

1/ Fry indices based on pre-emergent fry densities of sample stream adjusted for annual variation in proportion of total fry production due to sample streams and then weighted by 5-year average district escapements.

2/ Seawater temperatures for the months of March thru June at Juneau and Sitka are averaged.

3/ Fry indices based on pre-emergent fry densities of sample streams weighted only according to sampling effort.

4/ Seawater temperatures for the months March thru May. All seawater temperatures taken from monthly data sheets obtained from National Ocean Survey, NOAA, Rockville, Maryland.

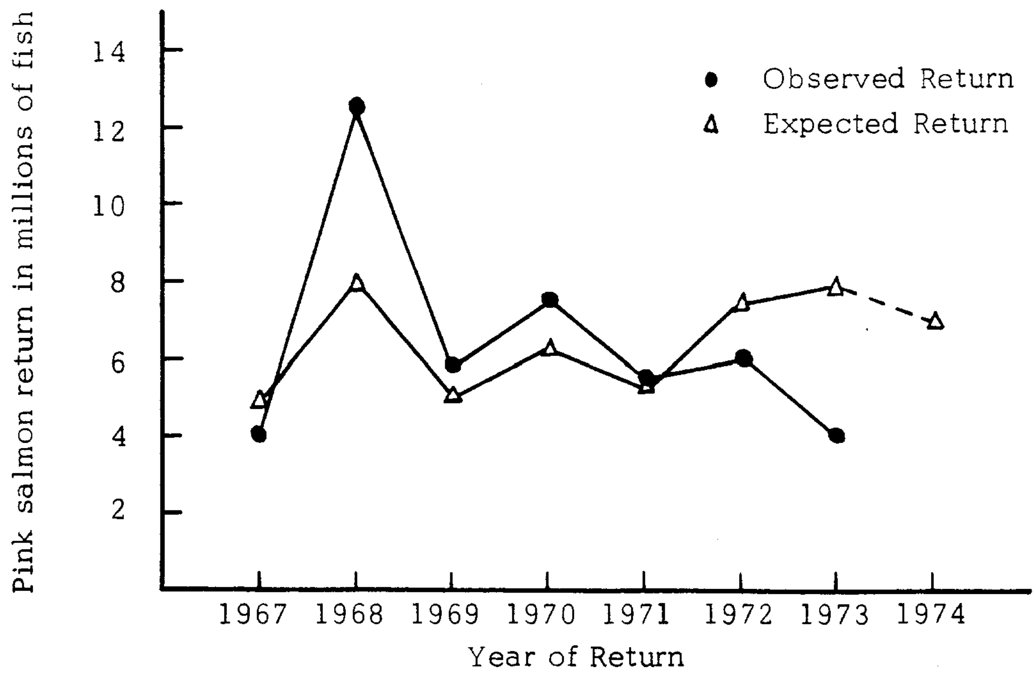


Figure 4A. Observed and expected mean pink salmon return strengths from a simple linear regression using weighted pre-emergent fry values and subsequent return, northern Southeastern.

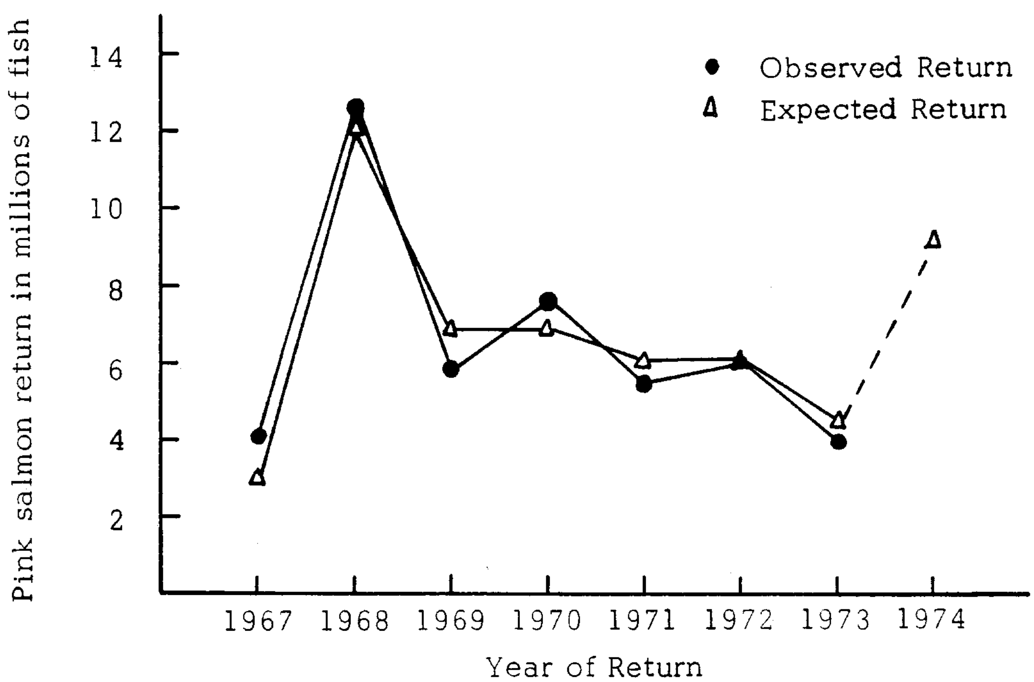


Figure 4B. Observed and expected mean pink salmon return strengths from a multiple regression using weighted fry values, seawater temperature at Juneau - Sitka and return, northern Southeastern.

X_2 = mean Juneau and Sitka surface seawater temperature during March, April, May and June in year previous to return

Using this equation, return strengths were estimated for each year of the period under study and compared with actual returns (Figure 4B). The standard error of estimate is $\pm$ 0.74 million pinks.

Thus a much better correlation between estimated and actual return is established by incorporating seawater temperatures with the fry abundance indices when relating them to the return.

Southern Southeastern. As in the north, the fry indices of individual streams in southern Southeastern were weighted according to sampling effort. However, additional weighting procedures were not used. Weighting by the district 5-year moving average escapement and adjusting for errors which might result from annual variation in sample stream contribution tended to increase variation in the fry-return relationship. It is not known exactly why these weighting procedures did not reduce standard error in the southern Southeastern fry-return relationship. Further investigation is planned, but for this forecast, data unweighted by escapement and showing the least standard error has been used.

Simple linear regression analysis of the pre-emergent fry index and return data (Table 2) for all the years of study shows these two factors are closely correlated ($r = 0.97$, $n = 7$). From the linear equation ($Y = -11.01 + 0.17X$) relating fry-return data, return strengths were estimated for each year and compared with the actual return strengths (Figure 5A). The average error of estimate is $\pm$ 1.26 million pinks.

The southern pre-emergent fry data, when combined with sea surface temperature data is closely correlated ($R = 0.99$, $n = 6$) with the return strength. The multiple regression equation for this relationship was calculated as follows:

$$Y = -20.789 + 0.169X_1 + 1.506X_2$$

where Y = return strength in millions of pinks

X_1 = weighted pre-emergent fry index in year previous to return

X_2 = mean Ketchikan surface seawater temperature during March, April and May in year previous to return

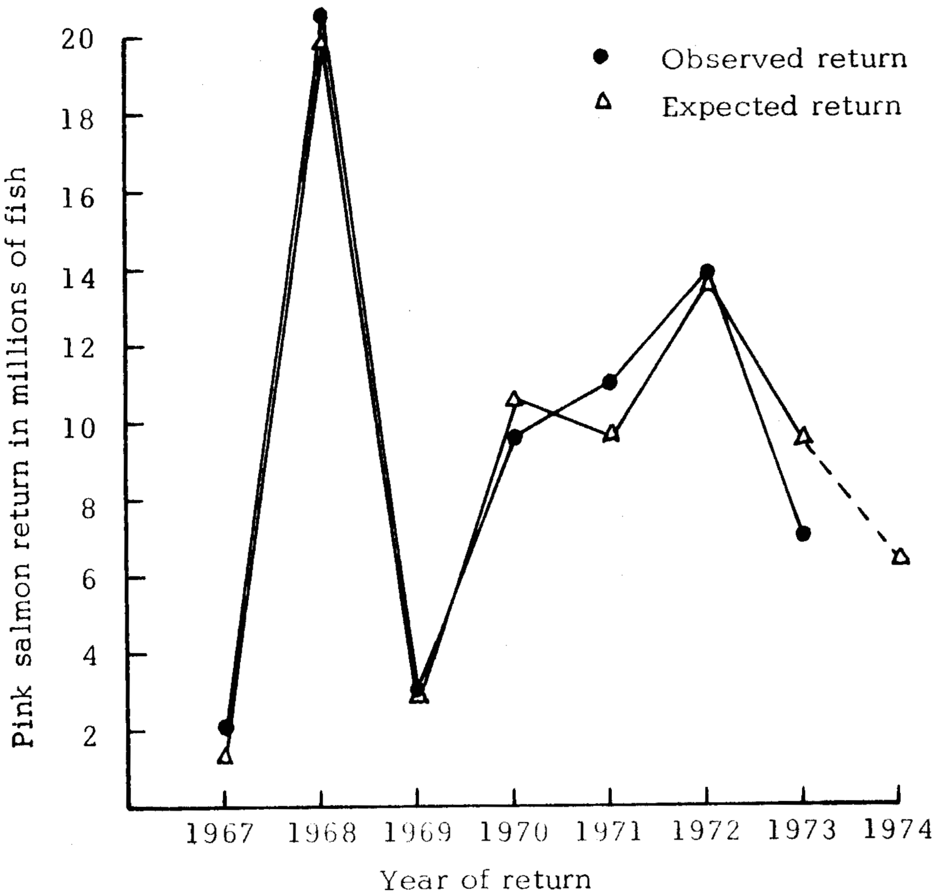


Figure 5A. Observed and expected mean pink salmon return strengths from a simple linear regression using pre-emergent fry values and subsequent return, southern Southeastern.

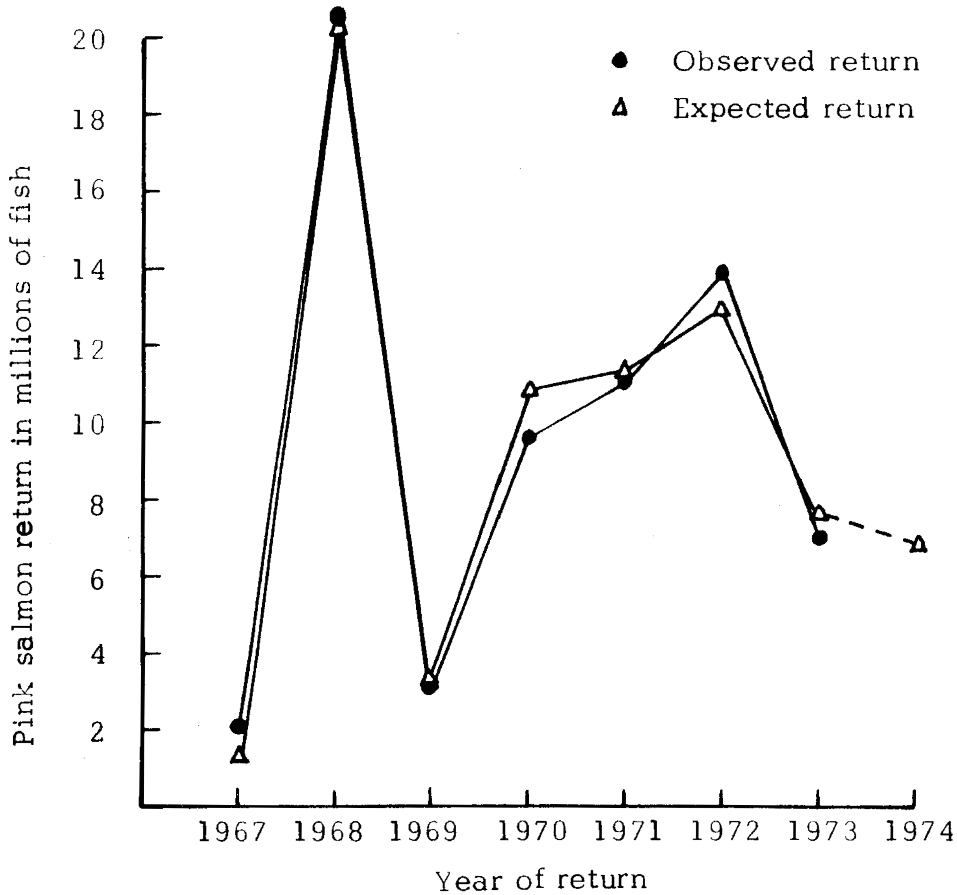


Figure 5B. Observed and expected mean pink salmon return strengths from a multiple regression using fry values, seawater temperatures at Ketchikan and return, southern Southeastern.

From this equation, return strengths were estimated for each year of the period under study and compared with actual returns (Figure 5B). The average error of estimate is ± 0.79 million pinks.

As with the northern Southeastern data, a better correlation between estimated return and actual return is established by incorporating seawater temperatures with the fry abundance indices when relating them to return.

Estimated 1974 Pink Salmon Return

The 1974 return to northern Southeastern is estimated at 9.3 million pink salmon, with a possible range of 7.4 - 11.2 million. The expected return to southern Southeastern is 6.8 million, with a possible range of 4.2 - 9.2 million.

The 1974 predictions were arrived at using the multiple regression equations discussed in the last section of this report. It is advisable not to become "locked-in" on the point estimate. Although the single figure forecast represents my best estimate of run size, the forecasted ranges must be considered. The ranges (80% confidence limits) are interpreted to mean that the actual return would be within the range of the estimate eight of ten years. As additional years' data are accumulated the width of the forecast range should narrow to the degree where even a returning run which is larger or smaller than the forecast range will still be acceptably close to the point estimate.

Estimated 1974 Returns of Early, Middle and Late Run Segments

The estimated size of runs by timing is based on the predicted return of 9.3 million pinks to northern and 6.8 million to southern Southeastern as well as on the possible range about the point estimates (Table 3).

The strength of runs by timing segment was determined by weighting the 1973 fry values of streams grouped by timing segment with the 1972 escapement by timing segment and then applying these percentages to the total return estimates.

For the purpose of this forecast the timing of runs is based on the time fish enter and spawn in their home streams. Most of the information on timing was provided by Area Management Biologists throughout Southeastern Alaska. Timing of entrance to spawning streams is divided into three segments--early (prior to August 10); middle (August 10 to September 1); and late (September 1 and later). Some difficulty was encountered in grouping streams because of the overlap in timing of runs to many streams. Preliminary stream groupings

Table 3. Estimated return, escapement index goals, and catch by timing segment, Southeastern Alaska, 1974. (In millions of pink salmon)

Northern Southeastern

	Return			Allowable Catch	
Timing 1/	Point Estimate	Range Estimate 2/	Escapement 3/ index goals	Point Estimate	Range Estimate
Early	4.9	3.9 - 5.9	1.7	3.2	2.2 - 4.2
Middle	2.9	2.3 - 3.5	0.7	2.2	1.6 - 2.8
Late	1.5	1.2 - 1.8	1.2	0.3	0.0 - 0.6
Totals	9.3	7.4 - 11.2	3.6	5.7	3.8 - 7.6

Southern Southeastern

	Return			Allowable Catch	
Timing	Point Estimate	Range Estimate	Escapement 3/ index goals	Point Estimate	Range Estimate
Early	1.8	1.1 - 2.4	1.1	0.7	0.0 - 1.3
Middle	2.9	1.9 - 3.9	2.4	0.5	0.0 - 1.5
Late	2.1	1.4 - 2.9	1.7	0.4	0.0 - 1.2
Totals	6.8	4.4 - 9.2	5.2	1.6	0.0 - 4.0

1/ Timing based on time pinks enter streams and commence spawning.
Early - prior to August 10
Middle - August 10 to September 1
Late - September 1 and later

2/ Range estimate at the 80% probability level.

3/ The desired escapement goals estimated from escapement history, 1960-1971, are 4.0 million pinks for the north and 6.0 million for the south. The escapement expectations have been reduced because several areas may have returns which will be less than that needed for escapement.

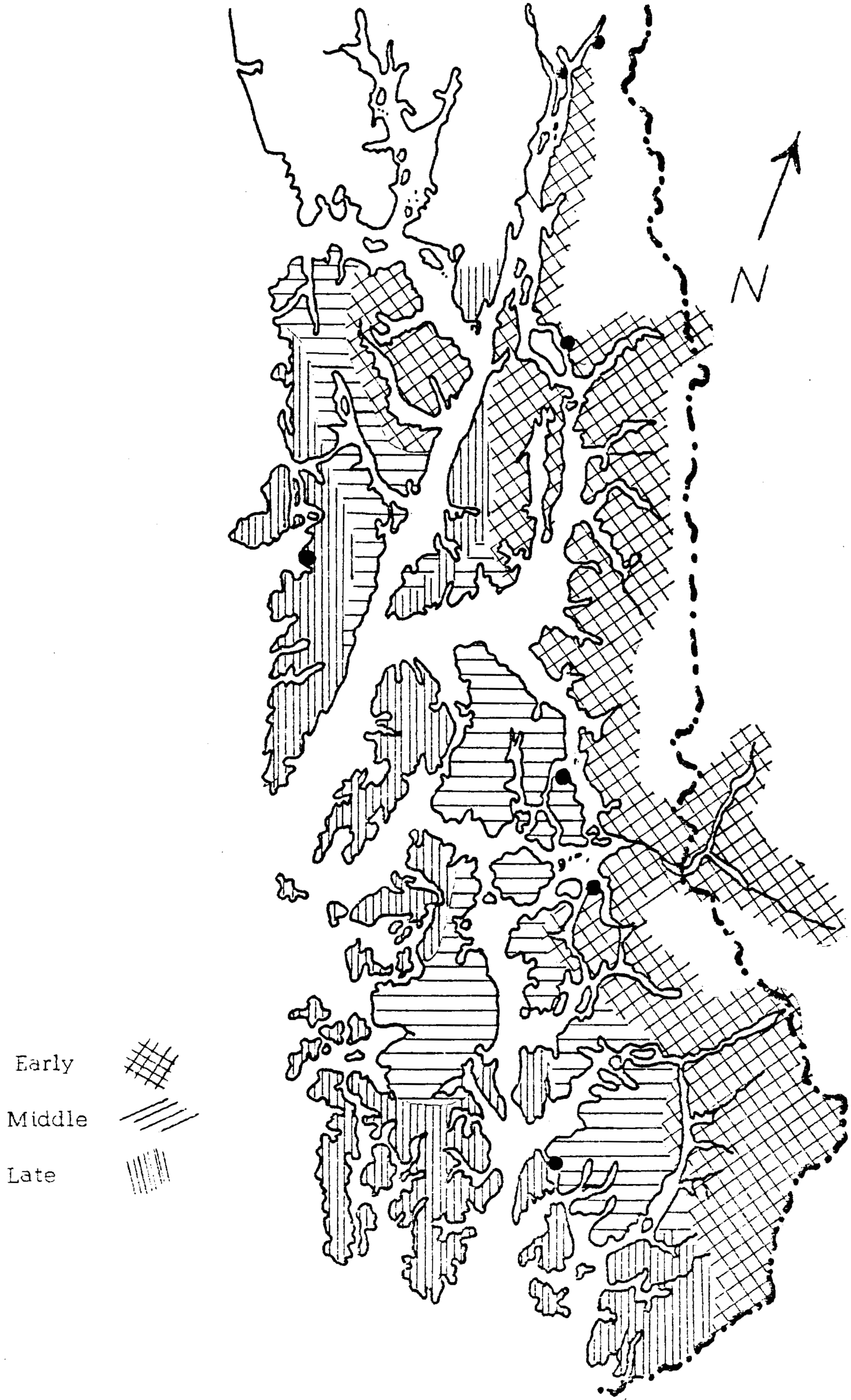


Figure 6. Time zones of pink salmon escapements in Southeastern Alaska used for 1974 timing forecasts.

were used to forecast the 1974 returns by timing (Figure 6). These groupings may change as more knowledge on timing of runs is acquired.

In northern Southeastern, approximately 53% of the total return is expected to be early run fish. An estimated 80% of these early run fish will be destined to the east side of Admiralty Island and the mainland streams (Regulatory Districts 10 and 11). Based on the range estimate this could mean an early run of anywhere between 3.9 to 5.9 million pinks with about 3.1 to 4.7 million of these returning to districts 10 and 11. Even with a relatively strong early run, several areas are expected to have poor returns, namely the early streams of Tenakee Inlet and the Icy Strait area. These systems are expected to contribute 20% of the early segment, or about 0.8 to 1.2 million pinks.

The middle run segment returning to northern Southeastern is expected to comprise about 32% of the total run, or about 2.3 - 3.5 million pinks. Weak returns are expected to the middle run streams in Icy Strait and Peril Strait, while the middle run segment to the Gambier-Pybus Bay area are expected to be strong.

The late run segment to northern Southeastern is expected to be only 15% of the return, or 1.2 - 1.8 million pinks.

In southern Southeastern, the early run segment should account for 26% of the return (Table 3). A major portion of the early fish will be destined for the early mainland streams in the back Behm Canal area. The early runs into the Ernest Sound area are expected to be very weak.

The middle and late run segments to southern Southeastern are expected to comprise the remaining 74% of the return or about 5.0 million pink salmon.

1974 Escapement Index Goals of Early, Middle, and Late Run Segments

The desired escapement index for northern Southeastern is 4.0 million and for southern Southeastern is 6.0 million (Durley and Seibel, 1972). These desired levels of escapement are based primarily on the escapement history and potential of major producing streams.

Escapement index goals are based on an assumed distribution of pink salmon to all districts and sections. Returns for 1974 as based on the point estimate are expected to be below minimally desired levels in some locations. As a result, escapement goals of 4 and 6 million pinks for northern and southern Southeastern are lowered to 3.6 and 5.2 million pinks, respectively. If, however, the returns are in the upper end of the forecast range, our original escapement goals could be achieved.

Escapement index goals to early, middle, and late streams were calculated by estimating the optimum escapement indices of all major surveyed streams, separating them into early, middle, and late and determining the percentage contribution of each segment to the total. The percentages were then applied to the escapement index goal of 3.6 million for the north and 5.2 million for the south (Table 3).

1974 Allowable Harvest Levels of Early, Middle and Late Run Segments

In northern Southeastern the estimated early run catch should be 3.2 million pinks with a possible range of 2.2 to 4.2 million (Table 3). This comprises about 60% of the total predicted catch. Catches should be limited to early stocks returning to the Stephens Passage area. Very poor early runs are expected to Icy Strait and Tenakee Inlet and these stocks should not be harvested. The early runs to Icy Strait should be given special attention since the run is expected to be only about 20% of the desired escapement. Thus, although return strength will be in the early segment, several early areas are still expected to have weak returns and must be protected.

The middle run catch in northern Southeastern should be about 2.2 million pinks with a possible range of 1.6 to 2.8 million. The major portion of the middle run catch should be from stocks returning to Admiralty Island. Middle run stocks returning to the Icy Strait streams are expected to be extremely weak, and as with the early segment returning to this area should not be harvested.

The predicted late run to northern Southeastern of 1.5 million pinks is extremely weak since the escapement goal of 1.2 leaves a catch of only 0.3 million with a possible range of 0.0 to 0.6 million. In order to assure adequate escapement to the late run streams very little fishing time is expected.

In southern Southeastern, the early catch should be 44% of the total catch or 0.7 million pinks. Most of this catch should be from the stocks destined for back Behm Canal. Very little surplus is expected to the Ernest Sound area. The allowable harvest could possibly vary from 0.0 to 1.3 million depending on the actual run strength.

The middle and late segment catch in southern Southeastern should be 56% of the total harvest or 0.9 million pinks with a possible range of 0.0 to 2.7. Stocks returning to middle and late run streams will be very spotty. No harvest can be expected from stocks destined to the middle run streams of Kasaan Bay and the west coast of Prince of Wales. The late run harvest is expected to be about 0.4 million.

Estimated 1974 Returns, Escapement Index Goals, and Expected Harvest Levels of Runs by Regulatory District

Valuable management data include an estimate of expected returns to each district. Southeastern Alaska is divided into 15 regulatory districts (Figure 7) most of which receive commercial numbers of pink salmon. The expected 1974 returns (Table 4) were determined by weighting the percent of the total 1972 escapement returning to each district by the subsequent fry indices and then applying these percentages to the total run prediction.

The breakdown by district indicates a rather uneven geographical distribution of return. In northern Southeastern approximately 65% of the return, or 6.0 million pinks are destined for the streams in districts 10 and 11. Based on the range estimate, the return to these districts might be anywhere between 4.8 and 7.2 million pinks. About 1.0 million pinks are expected to return to each of districts 9, 12 and 13. Only 0.1 million pinks are expected to return to district 14.

In southern Southeastern, approximately 47% of the return, or 3.2 million pinks are expected for the streams in district 1. All other districts in the southern half are expected to have extremely weak runs.

Districts 4, 8, and 15 are not included in the forecasts because of inadequate escapement data and no pre-emergent fry data.

The 1974 escapement to northern Southeastern should be about 3.6 million pink salmon, or 0.4 million less than the desired escapement level (Table 4). The prediction indicates district 14 will have a return of about 0.4 million less than that desired for the escapement. Inadequate escapement is expected to district 14, even if the total return is in the upper range.

The 1974 escapement to southern Southeastern should approximate 0.8 million less than the desired level. Districts 2 and 3 are expected to have runs of 0.3 million and 0.5 million pinks less than the desired escapement goal.

In northern Southeastern the allowable catch in 1974 should be approximately 4.5 million pinks of which 80% should come from the runs destined to districts 10 and 11. Fish destined to districts 9, 12, and 13 should be fished cautiously and the runs to district 14 should be protected entirely.

In southern Southeastern, the only appreciable harvest can be expected from district 1. Even if the upper range of the return estimate was experienced, catches would be predominately from this district. No harvest should occur on pinks destined for districts 2 and 3, even with a possible return as high as 9.2 million.

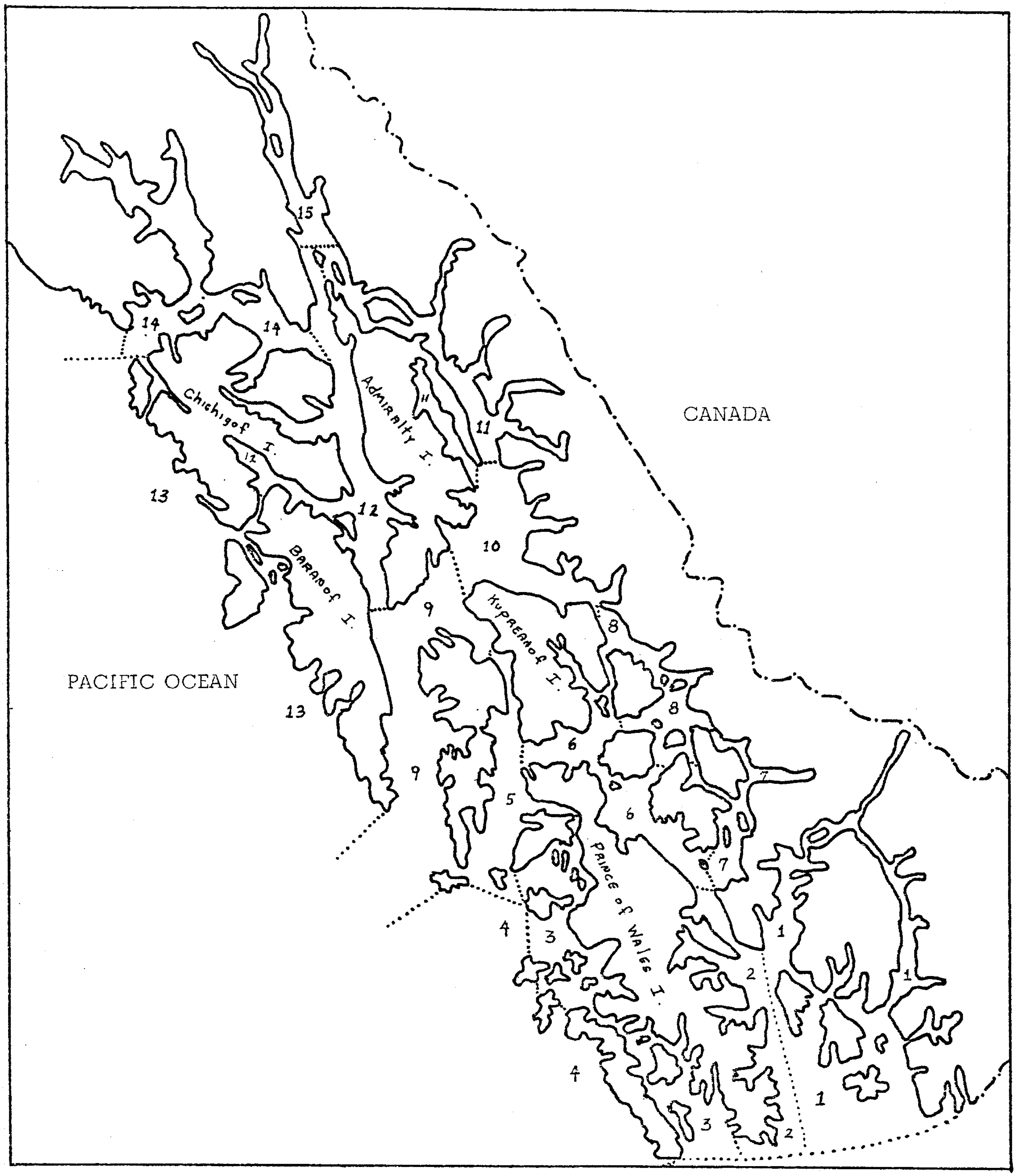


Figure 7. Map of Southeastern Alaska showing regulatory districts.

Table 4. District forecasts, escapement index goals and estimated allowable harvest, Southeastern Alaska, 1974. (Numbers of salmon in millions)

Northern Southeastern

District	Forecasted return: Point Estimate	Forecasted return: Range Estimate 1/	Escapement 2/ index goals	Allowable harvest: Point Estimate	Allowable harvest: Range Estimate
9	0.9	0.7 - 1.1	0.6	0.3	0.1 - 0.5
10	2.7	2.1 - 3.2	1.0	1.7	1.1 - 2.2
11	3.3	2.7 - 4.0	0.5	2.8	2.2 - 3.5
12	1.1	0.8 - 1.3	0.6	0.5	0.2 - 0.7
13	1.2	1.0 - 1.5	0.8	0.4	0.2 - 0.7
14	0.1	0.1 - 0.1	0.1	0.0	0.0 - 0.0
Totals	9.3	7.4 - 11.2	3.6	5.7	3.8 - 7.6

Southern Southeastern

District	Forecasted return: Point Estimate	Forecasted return: Range Estimate	Escapement index goals	Allowable harvest: Point Estimate	Allowable harvest: Range Estimate
1	3.2	2.1 - 4.4	2.0	1.2	0.1 - 2.4
2	0.3	0.2 - 0.4	0.3	0.0	0.0 - 0.1
3	1.2	0.8 - 1.7	1.2	0.0	0.0 - 0.5
5	0.6	0.4 - 0.8	0.5	0.1	0.0 - 0.3
6	0.8	0.5 - 1.1	0.6	0.2	0.0 - 0.5
7	0.7	0.4 - 0.8	0.6	0.1	0.0 - 0.2
Totals	6.8	4.4 - 9.2	5.2	1.6	0.1 - 4.0

1/ Range estimate is at the 80% probability level.

2/ The desired escapement goals estimated from escapement history, 1960-1971, are 4.0 million pinks for the north and 6.0 million for the south. Escapement expectations have been reduced because several areas may have returns less than that needed for escapement.

SUMMARY

An estimated return to northern Southeastern of 9.3 million pink salmon, with a possible range of 7.4 to 11.2 million and a return to southern Southeastern of 6.8 million pinks with a possible range of 4.2 to 9.2 million are forecasted for 1974.

Estuarine water temperatures were used for the first time to develop the forecast. A multiple regression relating pre-emergent fry abundance and spring estuarine temperatures to adult returns was used to formulate a prediction equation. Recent cold environmental conditions during the past two years appeared to have affected the survival of fry in the marine environment more adversely than during earlier years of study, and thus increased the error in forecasts based solely on pre-emergent fry index and adult return relationships. In both northern and southern Southeastern, the pre-emergent fry data when combined with seawater temperature data showed a close total correlation ($R = 0.96$ and $R = 0.99$, respectively) with the return strength versus the simple linear correlation of $r = 0.45$ for northern and $r = 0.96$ for southern Southeastern when only the pre-emergent fry data were related to adult return.

The forecast indicated a wide variation in expected run strengths by timing and by management area. In northern Southeastern, approximately 53% of the total return is expected to be early run pinks. An estimated 80% of those early run fish will be destined to regulatory districts 10 and 11. Even with a relatively strong early run segment, several early areas are expected to have poor returns, namely Tenakee Inlet and the Icy Strait areas. The middle run segment is expected to comprise about 32% of the total run, however, as with the early run segment, middle run systems in some areas (Icy Strait and Peril Strait) are expected to be weak, while in others (Gambier-Pybus bays) runs are expected to be strong. The late run segment to northern Southeastern is expected to be weak, contributing only 15% of the total return.

In southern Southeastern, the early run segment should account for 26% of the return. The major portion of the early pinks will be destined for the mainland streams in the back Behm Canal area. The early runs into the Ernest Sound area are expected to be very weak. The middle and late run segments to southern Southeastern are expected to contribute the remaining 74% of the total return.

Pink salmon escapements to Southeastern Alaska in 1974 are expected to be below the desired index levels of 4.0 million for northern and 6.0 million pinks for southern Southeastern. Because several areas are expected to have returns less than that desired for escapement, the escapement goals will probably not be achieved and the escapements will be approximately 3.6 million pinks for

northern Southeastern and 5.2 million for southern Southeastern.

Based on the 1974 escapement index goals, the allowable harvest levels would be approximately 5.7 million pinks in northern Southeastern and 1.6 million in southern Southeastern. However, actual catches in 1974 may vary from 3.8 to 7.6 million fish in the north and from 0.0 to 4.0 million in the south depending on the magnitude of actual total returns. It is therefore important not to become restricted by the point estimates of return. Although these are our best estimates, the possible range in predicted returns must be considered.

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